# A SECOND ASSEMBLAGE OF PLIOCENE INVERTEBRATE FOSSILS FROM LANGEBAANWEG, CAPE

By

Brian Kensley

*South African Museum, Cape Town*

(With 16 figures)

[*MS. accepted 30 November 1976*]

ABSTRACT

An assemblage of fossils from the Quartzose Sand Member of the Varswater Formation at Langebaanweg is described. The assemblage consists of 20 species of gasteropods, 2 species of bivalves, 1 amphineuran species, about 4 species of ostracodes, and the nucules of a species of the alga *Chara* (stonewort). Included amongst the molluscs is a new species of *Bullia*, to be described later by P. Nuttall of the British Museum, and a new species of the bivalve genus *Cuna* described here. The molluscs represent a mixture of marine, marine/estuarine, estuarine, freshwater, and terrestrial species. The ostracodes are all freshwater species. From the condition and relative abundance of the fossils, it is suggested that the specimens were deposited under very calm conditions in an estuarine area, perhaps after riverine flooding.

## CONTENTS



## INTRODUCTION

The commercial phosphate mine at Langebaanweg, Cape, has yielded a vast array of fossils, mainly of Pliocene age (*vide* Hendey 1976). The fossils are derived from the Varswater Formation, the geology of which is dealt with in some detail by Tankard (1975*b*). An assemblage of invertebrate fossils from the Gravel Member of this formation has been described (Kensley 1972). This suite was composed mainly of marine gasteropod and bivalve molluscs (both fossil shells and shell casts) but also included a single brachiopod and echinoderm, and barnacle fragments. Expansion of the quarrying activities has since exposed a second assemblage of invertebrate fossils in the south-western part of the mine. This material occurred in a mud deposit within the Quartzose Sand Member, which immediately overlies the Gravel Member. These are the fossils dealt with in the present report. All the material is housed in the South African Museum, whose catalogue numbers they bear.



*Ann. S. Afr. Mus.* **72** (10), 1977: 189–210, 16 figs.

## SYSTEMATIC DISCUSSION

## MOLLUSCA

### Class GASTEROPODA

### Family **Trochidae**

#### *Gibbula benzi* (Krauss)

*Gibbula benzi:* Barnard, 1963: 276.

*Material*

Single specimen, height 4,4 mm, width 5,0 mm.

*Distribution*

Living: East London to Saldanha.

*Remarks*

The colour pattern of white dots on the periphery, rows of dark and light dots on the base, and the spire slightly mottled, is well preserved.

#### *Oxystele variegata* (Anton)

*Oxystele variegata:* Tankard, 1975*a*: 22.

*Material*

Single specimen, height 6,0 mm, width 10,0 mm.

*Distribution*

Living: Natal to southern Angola.
Fossil: Port Elizabeth, Verlorevlei, Saldanha.

*Remarks*

The general colour of the specimen is dark brown, but remains of the colour pattern are still visible.

### Family **Phasianellidae**

#### *Tricolia capensis* (Dunker)

Fig. 1

*Tricolia capensis:* Barnard, 1963: 206.

*Material*

Numerous specimens, from 1,6 mm to 4,0 mm in height.

*Distribution*

Living: False Bay to Kunene River mouth.

*Remarks*

All the specimens retain the characteristic colour pattern of a pale ground with darker pink-brown spots and mottling.

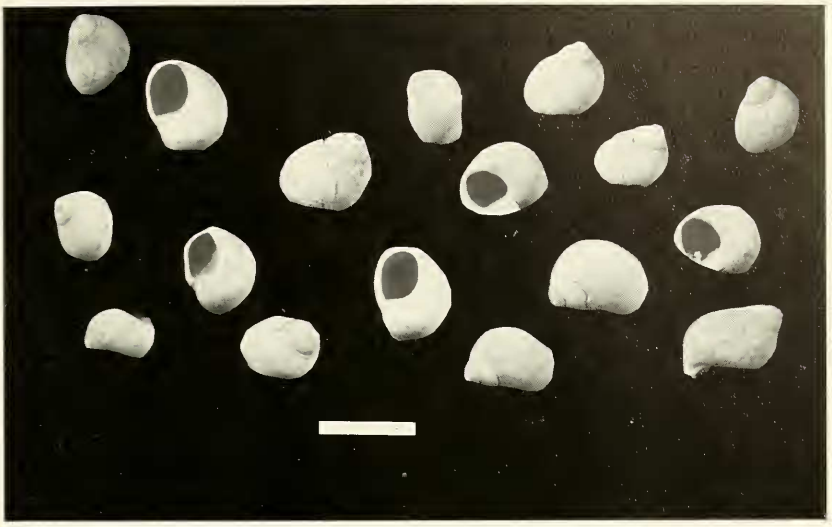

Fig. 1. *Tricolia capensis* (scale = 3 mm).

*Tricolia neritina* (Dunker)

*Tricolia neritina:* Kensley, 1972: 177.

*Material*

Two specimens, greatest diameter 3,4 mm, 2,0 mm.

*Distribution*

Living: East London to South West Africa.
Fossil: Langebaanweg.

*Remarks*

Both specimens retain the spiral colour bands of this species.

Family **Littorinidae**

*Littorina* cf. *knysnaensis* (Philippi)

*Littorina knysnaensis:* Tankard, 1975*a*: 22.

*Material*

Two damaged specimens, greatest diameter of larger specimen 5,0 mm.

*Distribution*

Living: Natal to Rocky Point, South West Africa.
Fossil: Saldanha, Verlorevlei, Knysna.

*Remarks*

Both specimens are low-spired, showing about twenty-five spiral lines on the body whorl, plus numerous fine growth lines characteristic of this species. A basal keel as is found in specimens living in strong wave action, is not present.

Family **Collumbellidae**

*Pyrene albuginosa* (Reeve)

Fig. 2

*Pyrene albuginosa:* Barnard, 1962: 190.

*Material*

Thirteen specimens ranging in height from 3,5 mm to 7,4 mm.

*Distribution*

Living: Natal to False Bay.
Fossil: Port Elizabeth.

*Remarks*

Several of the specimens show two irregular rows of white spots on the body whorl, white spots at the suture, and a darker reticulation between the spots.

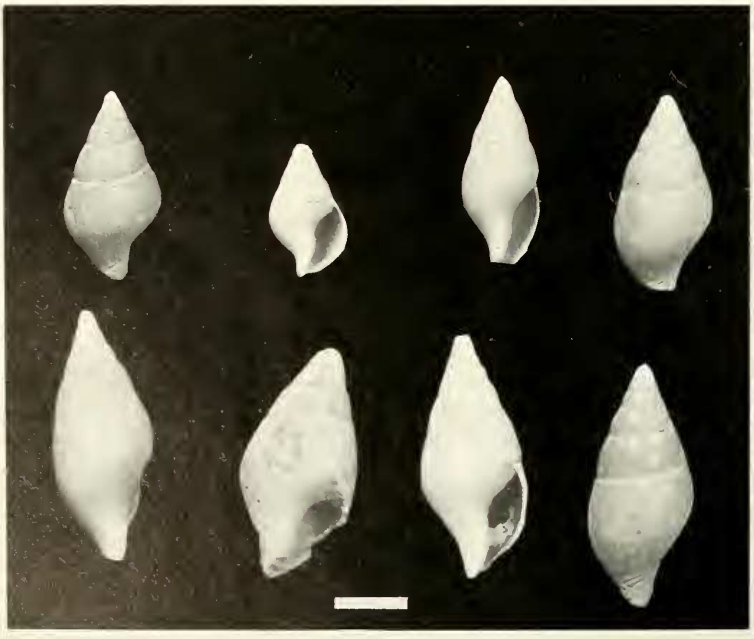

Fig. 2. *Pyrene albuginosa* (scale — 2 mm).

## Family **Nassariidae**

### *Bullia digitalis* (Meuschen)

*Bullia digitalis:* Barnard, 1959: 137.
*Bullia* sp. Kensley, 1972: 179.

*Material*

Ten specimens, all damaged, largest 20 mm length.

*Distribution*

Living: Port Elizabeth to Walvis Bay.
Fossil: Lüderitz, Orange River, Langebaanweg, Keurbooms River.

### *Bullia laevissima* (Gmelin)

*Bullia laevissima:* Tankard, 1975*a*: 23.

*Material*

Eight specimens, all damaged, length 6,0 mm to 21,0 mm.

*Distribution*

Living: Port Alfred to Walvis Bay.
Fossil: Bogenfels, Saldanha, Knysna.

### *Bullia* sp.

Fig. 3

*Remarks*

Large numbers of this species varying in size from protoconch plus a few postnatal whorls, to specimens up to 18 mm in length have been collected. P. Nuttall of the British Museum is of the opinion that this is an undescribed species and will be dealing with it in a later work.

### *Nassarius* cf. *analogicus* (Sowerby)

Fig. 4

*Nassa analogica:* Barnard, 1959: 99.
*Nassarius analogicus:* Tankard, 1975*a*: 22.

*Material*

Three specimens, protoconchs missing, length 16,2 mm to 18,9 mm.

*Distribution*

Living: East London to St Helena Bay.
Fossil: Saldanha.

*Remarks*

Although the specimens are very worn, traces of the spiral lirae characteristic of this variable species can be seen. Only faint traces of axial ribs are visible on the upper whorls.

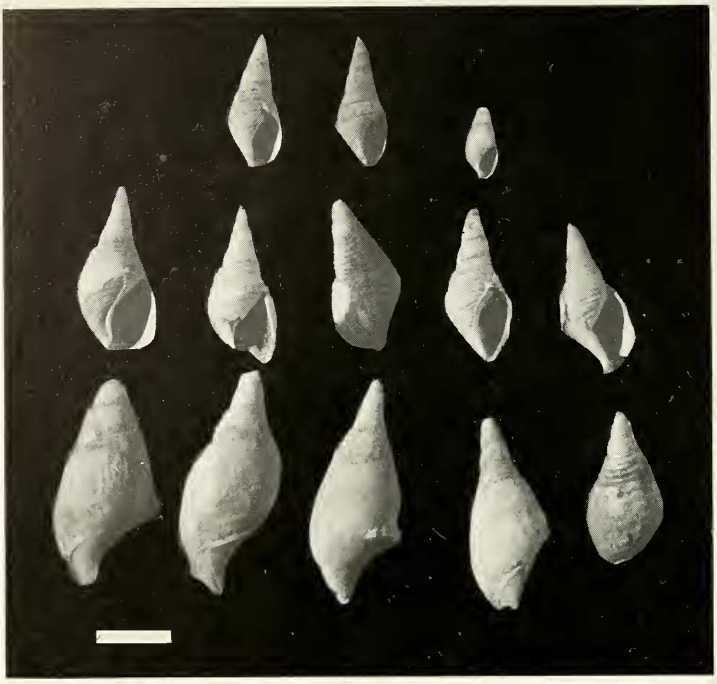

Fig. 3. *Bullia* sp. (scale 5 mm).

Fig. 4. *Nassarius* cf. *analogicus* (scale = 4 mm).

*Nassarius* sp.

Fig. 5

*Description*

Protoconch smooth, $2\frac{1}{2}$ whorls; 2 postnatal whorls, first whorl with 14–15 axial ribs, second whorl with 14–15 ribs. First whorl with 5 spiral lirae, 6–7 on second whorl, 4 on rostrum, 4–5 slightly stronger lirae on base.

*Material*

One damaged specimen, outer lip broken, length 3,3 mm, width 1,8 mm.

*Remarks*

The specimen agrees well with material of *N. plebeja* (Thiele) from Port Elizabeth, and with Barnard's (1959: 106) description. As this living species has only been recorded from relatively deep water (80–100 metres) no certainty can be placed on this identification.

*Nassarius* sp.

Fig. 6

*Description*

Protoconch plus $4\frac{1}{2}$ whorls, outer lip and base of shell damaged. Spire tapering evenly, apical angle 45°. Axial ribs well separated bent slightly near upper suture, and forming barely perceptible shoulder, 9–11 axial ribs per whorl. Periphery of body whorl with single spiral lira stronger than other faint lirae, latter almost obscure, about twelve per whorl.

*Material*

One specimen, damaged, length 15,5 mm width 7,0 mm.

Fig. 5. *Nassarius* sp. (scale = 1 mm).

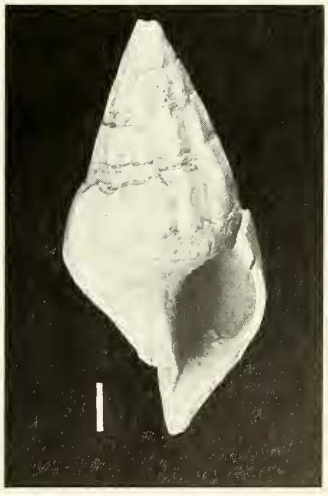

Fig. 6. *Nassarius* sp. (scale = 2 mm).

*Remarks*

The specimen closely resembles *N. scopularcus*, known as a Tertiary fossil from Bogenfels, Saldanha, and taken alive from Langebaan and Lüderitz, but differs in the shape of the profile. *N. scopularcus* has a slightly convex profile, as opposed to the present straight-sided specimen.

Family **Marginellidae**

*Marginella* sp.

*Material*

One specimen, length 2,9 mm.

*Remarks*

This species belongs to the group possessing a smoothly convex shoulder, three columellar pleats. In general form there is some resemblance to *M. differens.*

Family **Assimineidae**

*Assiminea* sp.

Fig. 7

*Material*

Numerous specimens, length ranging from 2,4 mm to 4,0 mm.

Fig. 7. *Assiminea* sp. (scale = 3 mm).

*Remarks*

In proportions this species resembles *A. bifasciata* but does not appear to reach this species size. The present species is not quite as rounded and squat as *A. globulous*, but falls within that species size range.

Family **Ferrissiidae**

*Burnupia capensis* (Walker)

Fig. 8

*Burnupia capensis:* Connolly, 1939: 521. Burch, 1975: 54.

*Material*

Numerous specimens, largest length 4,0 mm, width 2,3 mm.

*Distribution*

Living: Natal to southern Cape and Cape Peninsula.
Subfossil: from vlei deposit, Cape St Francis.

*Remarks*

As Burch (1975) has shown, the nature of the apical sculpture in the freshwater limpets is a very useful feature for separation of species. With this in view, scanning electron micrographs were obtained of the present material. These show the subapical rows of pits characteristic of *B. capensis*, but the rows of pits are not as numerous as in the modern material figured by Burch. The shape of the pits, however, is closer to *B. capensis* than to *B. stenochorias* with its sparser pit rows. None of the present specimens reach the size of the type or the fresh material in the South African Museum (i.e. up to 7,5 mm in length) of *B. capensis*, which is itself a smaller species than a normal *B. stenochorias* (length 8,5 mm).

Family **Planorbidae**

*Ceratophallus natalensis* (Krauss)

Fig. 9

*Planorbis natalensis* Krauss, Connolly, 1939: 490.
*Ceratophallus natalensis:* Brown & Mandahl-Barth, 1973: 289.

*Material*

Numerous specimens, greatest diameter 4,7 mm.

*Distribution*

Living: eastern Africa from Eritrea to eastern Cape, westwards to Chad and lower Congo.

*Remarks*

Connolly notes that populations of this species may for years remain below the normal adult dimensions before reaching full size. This may account for the small average size of the present material.

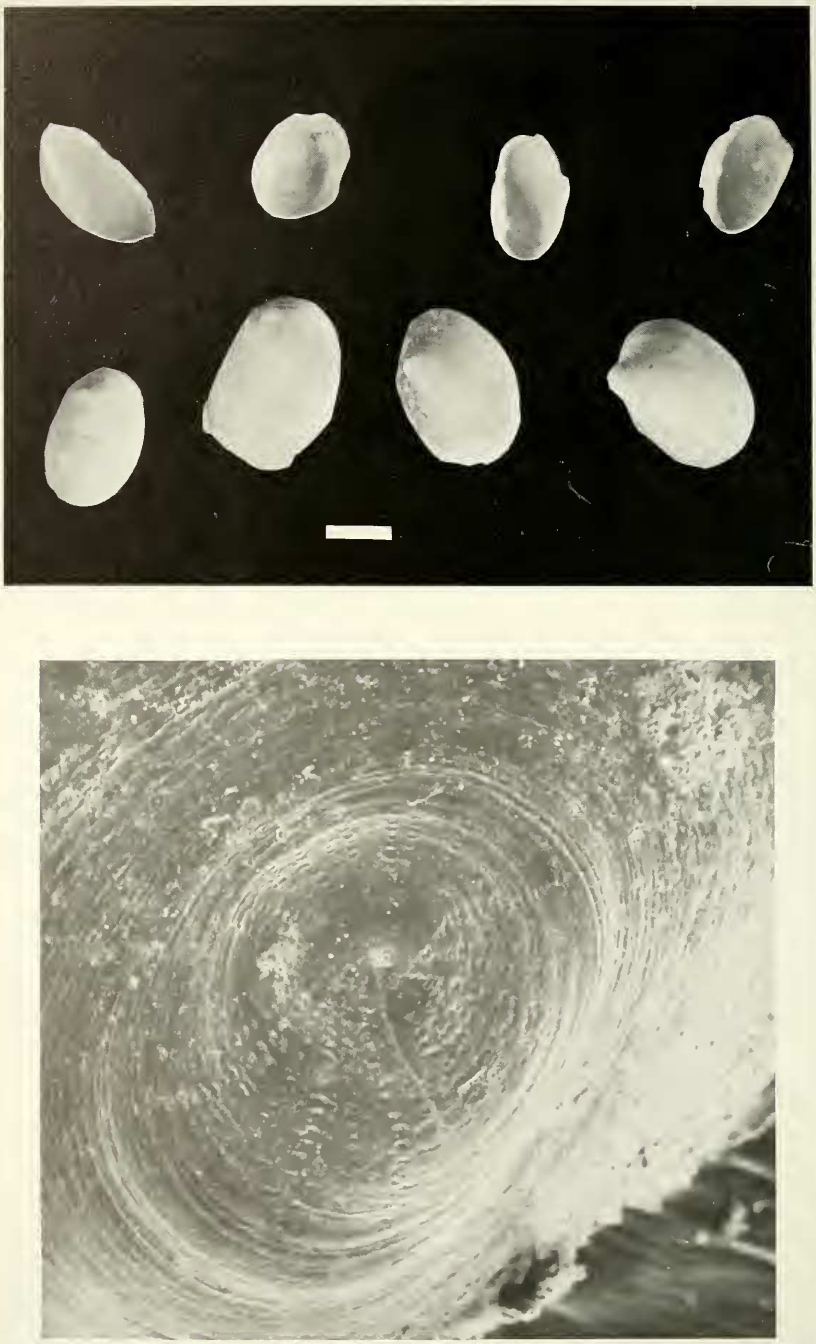

Fig. 8. *Burnupia capensis* (scale = 1 mm) with electromicrograph enlargement of apex.

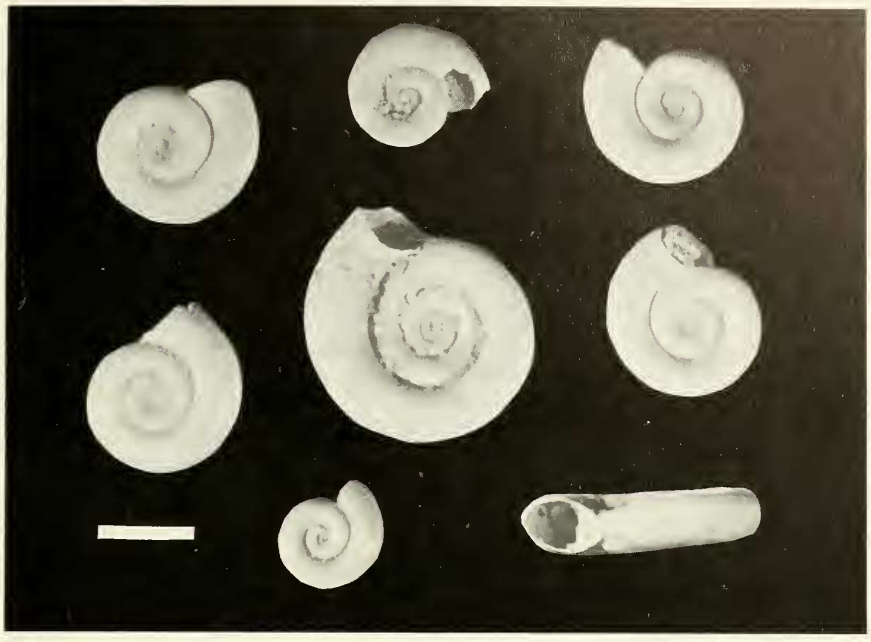

Fig. 9. *Ceratophallus natalensis* (scale = 2 mm).

*Bulinus* '*tropicus*' (Krauss)

Fig. 10

*Bulinus tropicus:* Connolly, 1939: 499.

*Material*

Numerous specimens. Largest, length 3,9 mm, width 3,2 mm.

*Distribution*

Living: entire Republic of South Africa, Lesotho, Rhodesia, Botswana. Subfossil: South West Africa.

Family **Endodontidae**

*Trachycystis* cf. *capensis* (Pfeiffer)

Fig. 11

*Trachycystis capensis:* Connolly, 1939: 228. Van Bruggen, 1970: 457.

*Material*

Seven specimens up to 4,2 mm width, 2,7 mm length.

*Distribution*

Living: East London to Orange River Mouth, common in coastal sand dunes, seldom extending more than 24 km inland. Recorded from 'Langebaan, under stones in dry sand fields' (Van Bruggen 1970: 458).

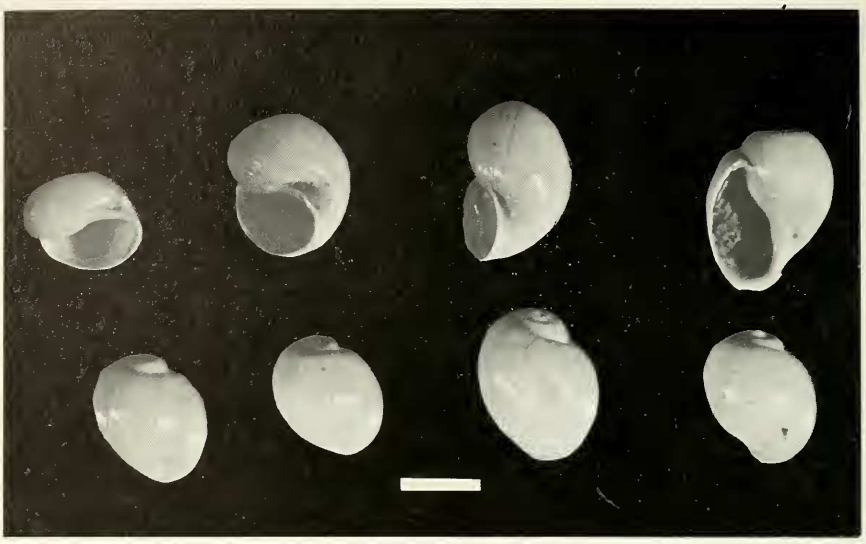

Fig. 10. *Bulinus* '*tropicus*' (scale = 2 mm).

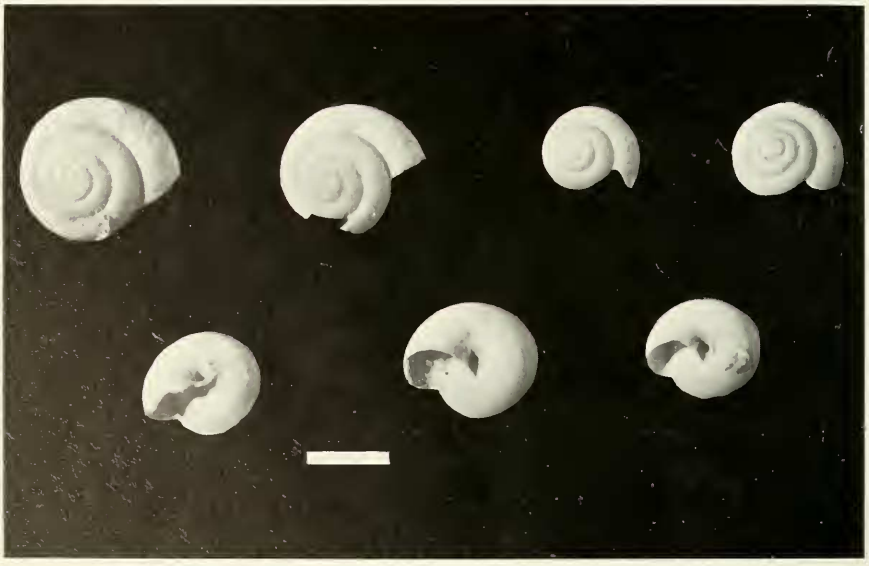

Fig. 11. *Trachycystis* cf. *capensis* (scale = 2 mm).

Family **Succineidae**

*Succinea* sp.

Fig. 12

*Material*

One specimen, length 3,3 mm, width 1,9 mm.

*Remarks*

In the relatively slender shape of the dextral shell, its very delicate structure, this specimen resembles the genus *Succinea*. Without more material (and the lack of soft parts) further identification is not possible.

Family **Hydrobiidae**

*Tomichia ventricosa* (Reeve)

*Tomichia ventricosa:* Connolly, 1939: 573.

*Material*

Two fragments.

*Distribution*

Living: southern Cape and Cape Peninsula.

*Remarks*

Although the material is fragmented, it agrees well with subfossil as well as fresh material of this species.

Fig. 12. *Succinea* sp. (scale = 1 mm).

? Family

Fig. 13

*Material*

Numerous shell apices, lower portion of shell never present, maximum diameter 4,0 mm.

*Remarks*

There can be no certainty about the status of this species until a complete specimen is found. The very flattened spire is similar to that of many of the Naticidae. The rather delicate shell, however, is unlike most *Natica* species, and the possibility that this is a freshwater or terrestrial species cannot be ruled out.

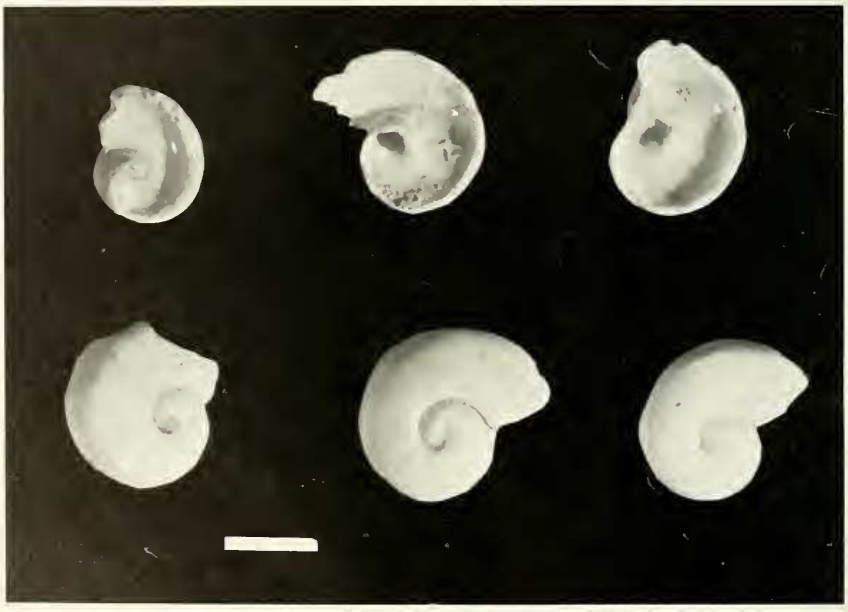

Fig. 13. ? Family (scale = 2 mm).

Class AMPHINEURA

Family **Chitonidae**

*Chiton nigrovirescens* (Blainville)

Fig. 14

*Chiton nigrovirescens:* Barnard, 1963: 342.

*Material*

Single valve, 11,5 mm wide.

*Distribution*

Living: False Bay to Lüderitz.

*Remarks*

The single valve agrees exactly with a valve taken from a living animal, in the shape of the apophyses, the ribbed lateral area and the pectinate margin with its single slit.

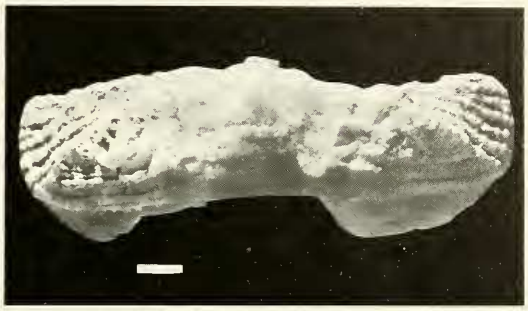

Fig. 14. *Chiton nigrovirescens* (scale = 1 mm).

Class PELECYPODA

Family **Donacidae**

*Donax serra* (Röding)

*Donax serra:* Tankard, 1975*a*: 24.
*Donax* cf *serra* and *Donax* sp., Kensley, 1972: 183.

*Material*

Numerous fragments of left and right valve hinges, also several fragments of the blade of the shell.

*Distribution*

Living: Kei Mouth to Walvis Bay.

Fossil: Angras Juntas, Oranjemund, Alexander Bay, Saldanha, Langebaanweg, Milnerton, Sedgefield.

*Remarks*

All the material is very fragmented, mainly hinge-lines surviving. Nevertheless, comparison with recent material of similar size shows no differences in hinge structure, while the characteristic serrations of the lower margin of this species are visible in some of the fragments.

Family **Carditidae**

***Cuna aquaedulcensis*** sp. nov.

Fig. 15

*Description*

Valves inequilateral, umbo to anterior margin longer than umbo to posterior margin length. Posterior margin straight. Sculpture consisting of 20–21

radiating ribs crossed by numerous concentric growth lines, thus forming elongate-rounded tubercles. Inner ventral margin crenulate, mantle line uninterrupted. Hinge line with anterior cardinal tooth elongate, low; posterior cardinal tooth reduced to low knob. Median tooth relatively strong, narrowly triangular, separated from anterior tooth by narrow gutter. Posterior tooth forming part of shell margin. Single low lateral tooth on anterior margin.

*Material*

Holotype, right valve, length 3,4 mm, height 3,1 mm, SAM–L25892W.
Paratype, right valve, length 3,4 mm, height 3,1 mm, SAM–A25892W.

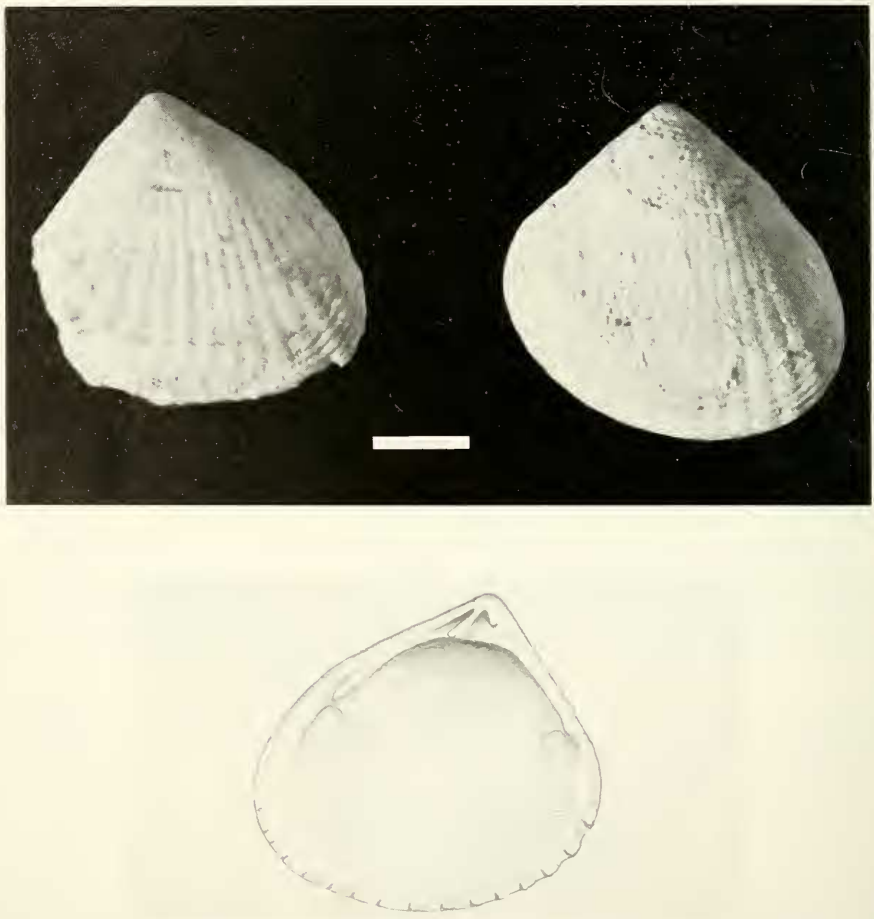

Fig. 15. *Cuna aquaedulcensis* (scale = 1 mm).

*Remarks*

This species most closely resembles the West African *Cuna gambiensis* Nicklés, 1955. This similarity lies in the overall proportions, and in the external sculpture. The West African species, however, has more radiating ribs (26) than *C. aquaedulcensis*, while examination of the hinge lines shows obvious differences. The right valve of *C. gambiensis* possesses three distinct cardinal teeth, while the posterior cardinal tooth in the present species is reduced to a knob. Little is known of the habits of these tiny bivalves. The specific name is derived from the Varswater (freshwater) Formation in which it was found.

## ARTHROPODA

### Class CRUSTACEA

### Subclass OSTRACODA

A vast number of perfect ostracode valves, often both valves together, was obtained by sieving of the present sediments. Only about 5 species appear to be present, and of these 2 are abundant, the other 3 relatively uncommon. Difficulty was experienced in identifying these latter; one is probably a *Heterocypris* sp. There is little doubt, however, that the ostracodes are of freshwater origin.

#### Family **Cytheridae**

#### *Gomphocythere expansa* (Sars)

*Gomphocythere expansa:* McKenzie, 1971: 162, 195.

*Distribution*

Living: known only from the Cape Flats.

*Remarks*

This is the most abundant ostracode in the sediments, and occurs in thousands, often with the two valves joined. The very tumid shape and the flattened ventral surface with its sharply marked ridge make this species quite distinctive. Comparison with Sars's type material revealed no differences from the present material.

#### Family **Cyprididae**

#### *Zonocypris cordata* (Sars)

*Zonocypris cordata:* McKenzie, 1971: 169, 194.

*Distribution*

Living: vicinity of Cape Town, Port Elizabeth.

*Remarks*

This is the second most abundant species from the sediments, very often occurring with both valves joined. Comparison with Sars's type material revealed no differences.

## CHAROPHYCOPHYTA (Stoneworts)

*Chara* sp.

Fig. 16

*Material*

Numerous nucules (♀ sexual reproductive structures).

*Remarks*

In spite of their varying proportions, these nucules are all composed of four spiral cells, thus placing the material in the genus *Chara*. R. D. Wood, of the University of Rhode Island, U.S.A., who looked at the material, gave the opinion that all the nucules belonged to the same species, variation in proportions being quite usual. Without further structures, specific identification is difficult. However, two possibilities present themselves:

*Chara globularis* a brackish water species usually living in water of a salinity of 5–15‰.

*Chara vulgaris* a purely freshwater species.

This is the first record of a fossil alga from Langebaanweg. Previous plant remains from the area include roots and pollen grains from the peat deposit, as well as plant fragments (Hendey 1976: 243).

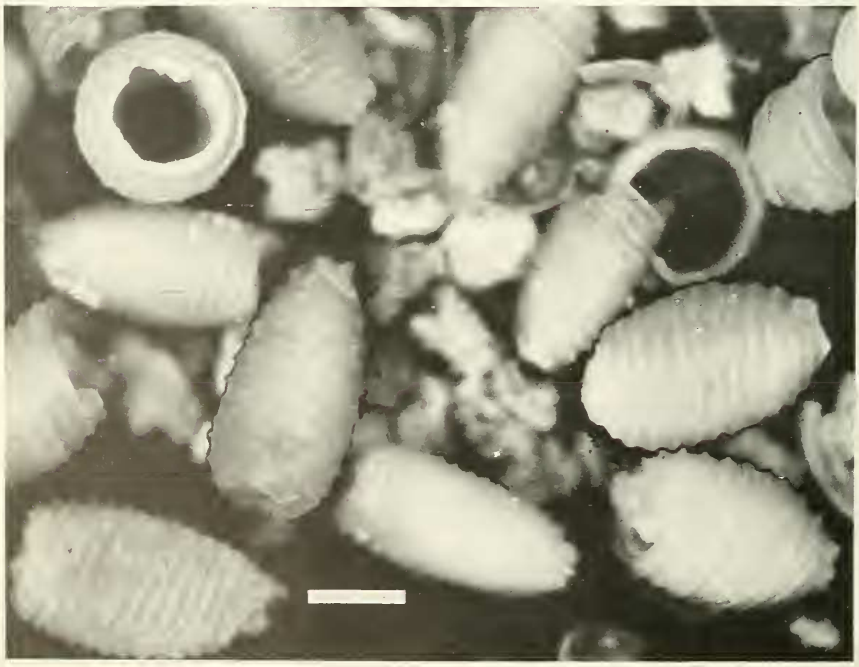

Fig. 16. Nucules of *Chara* sp. (scale = 0,4 mm).

## GENERAL DISCUSSION

As already mentioned, this assemblage of fossils was recovered from a fine-grained horizon in the Quartzose Sand Member of the Varswater Formation. Speculation on the environmental conditions under which the animals lived can be aided by two sources of information, viz. knowledge of the geology of the area, and present-day ecological knowledge of the same or related species.

Regarding the geological evidence, Tankard (1975*b*) has described the broad series of events in the area, viz. a marine transgression in the Pliocene, the accumulation of freshwater estuarine sands behind a barrier followed by a final marine transgression. In the Quartzose Sand Member Tankard recognizes in the sediments a fluviatile facies as well as an estuarine facies. A broad analysis of the present fossil assemblage and what knowledge we have of the environmental niches of these species, supports to some extent this geological view.

The fossils may be divided into the following categories:

MARINE SPECIES

*Bullia digitalis*
*Chiton nigrovirescens*
*Donas serra*
*Gibbula benzi*
*Pyrene albuginosa*
*Tricolia capensis*
*Tricolia neritina*

MARINE/ESTUARINE SPECIES

*Bullia laevissima*
*Littorina cf knysnaensis*
*Marginella* sp.
*Nassarius* spp.
*Oxystele variegata*

ESTUARINE SPECIES

*Assiminea* sp.

FRESHWATER SPECIES

*Ceratophallus natalensis*
*Bulinus tropicus*
*Burnupia capensis*
*Chara* sp.
*Gomphocythere expansa*
*Succinea* sp.
*Tomichia ventricosa*
*Zonocypris cordata*

TERRESTRIAL SPECIES

*Trachycystis capensis*

Under the marine/estuarine group are included species which have been recorded in both habitat types, as well as those forms which are only tentatively identified, and whose genera are usually marine, but sometimes also estuarine, e.g. *Nassarius*.

The assemblage is thus obviously a mixture of species from a variety of habitats, with major contributions from the marine and the freshwater representatives. If the assemblage is looked at in terms of abundance (even though

no quantitative collecting as such was done), it becomes apparent that a few species are very common, the rest being rare. These abundant species are the following:

| MARINE SPECIES | FRESHWATER SPECIES |
|---|---|
| *Tricolia capensis* | *Ceratophallus natalensis* |
| | *Bulinus tropicus* |
| | *Burnupia capensis* |
| | *Gomphocythere expansa* |
| | *Zonocypris cordata* |

The new species of *Bullia* is probably not a freshwater species, but whether it is purely marine or marine/estuarine, is uncertain. The abundance of all stages of these *Bullia* shells, and their good state of preservation, however, suggests that this was an estuarine species.

To speculate on the environmental conditions at the time of deposition, not only the species composition (and their ecological implications) must be considered, but also the sediments and the state of preservation of the fossils. The following points are of relevance in this connection: the sediments are very fine with a considerable clay fraction; many of the ostracodes are undamaged and often both valves are still joined; the nucules of *Chara* are often complete, in spite of the very delicate and brittle nature of the spiral cells; *Bulinus*, *Burnupia*, and *Ceratophallus* are small, very delicate shells, yet the majority of specimens are undamaged. Deposition must thus have taken place under very calm conditions.

To explain the presence of marine, estuarine, and freshwater species in the sediments, one must postulate a lagoonal/estuarine area, protected from wave action, yet with access to the sea. Close to this sea-mouth, there must have been both rocky shores (to accommodate *Tricolia*, *Pyrene*, *Oxystele*, and *Chiton*), and sandy shores (*Donax*, *Bullia digitalis*). Tidal movement could wash these marine forms into the sheltered lagoon, the larger shells such as *Donax* and *Bullia* becoming abraded and fragmented, the smaller shells of *Pyrene* and *Tricolia* surviving intact. (Movement of shells of the two former genera into a lagoon from the sea has been observed by the author at Milnerton.) That the rocky shores were nearby is implied from the condition of the *Pyrene* and *Tricolia* shells. These are without exception unworn, with the protoconches preserved, and in most cases, the colour patterns still visible. The true estuarine forms could have lived along the lagoonal/estuarine shores (*Assiminea* sp.) or on the muddy bottom (*Bullia laevissima*). The Charophyte alga probably flourished in a pond or temporary pool, isolated from the general estuary (as shown in Hendey 1976, fig. 2). (Charophytes, which are abundant on the present-day Cape Flats, are usually found in quiet ponds, shallow water holes, temporary pools, and dams (Stephens 1929).) The large numbers of fluviatile molluscs and ostracodes might have been washed in by seasonal floods, with the flood waters sweeping over nearby stagnant pools, finally to loose their

force and spread out in the lagoonal/estuarine area. Fine sediment in suspension, as well as the mollusc and ostracode shells and the charophyte nucules would then settle on the bottom, along with the marine/estuarine shells already there. Deposition of these sediments occurred during a stillstand in a marine transgression (Tankard 1975*b*: 271).

The presence of the terrestrial *Trachycystis* can also be explained by flooding, or by strong wind action.

Comparison between the present fossil suite and the assemblage previously recorded from the Gravel Member of the same formation, shows that only two species occur in both. These are *Bullia digitalis* and *Donax serra*, both marine sand-dwelling species, still occurring on the nearby coast at Saldanha. The general dissimilarity is not surprising in view of the fact that the Gravel Member material was evidently accumulated in a marine beach environment. The differences between the two assemblages do not necessarily have any temporal significance.

## ACKNOWLEDGEMENTS

I am grateful to Mr C. Appleton, Mr R. N. Kilburn, and Dr A. J. Tankard for reading the manuscript and for their useful criticisms; to Dr Q. B. Hendey for comments and for making the material available; to Prof. R. D. Wood of the University of Rhode Island, U.S.A., for his comments on the Charophytes; to Mr D. Gerneke for the photographs, and to Dr Tankard for arranging for the electromicrographs to be taken at Rhodes University, Grahamstown.

## REFERENCES

Barnard, K. H. 1959. Contributions to the knowledge of South African marine Mollusca. Part II. Gastropoda: Prosobranchiata: Rhachiglossa.—*Ann. S. Afr. Mus.* **45**: 1–237.

Barnard, K. H. 1962. Revised list of South African Late Tertiary and Pleistocene marine Mollusca.—*Trans. R. Soc. S. Afr.* **36**: 179–196.

Barnard, K. H. 1963. Contributions to the knowledge of South African marine Mollusca. Part IV. Gastropoda: Prosobranchiata: Rhipidoglossa, Docoglossa. Tectibranchiata. Polyplacophora. Solenogastres. Scaphopoda.—*Ann. S. Afr. Mus.* **47**: 201–360.

Brown, D. S. & Mandahl-Barth, G. 1973. Two new genera of Planorbidae from Africa and Madagascar.—*Proc. malac. Soc. Lond.* **40**: 287–302.

Burch, J. B. 1975. Apical shell sculpture of some African freshwater limpets (Mollusca: Basommatophora: Ancylidae).—*Zool. afr.* **10**: 53–62.

Connolly, M. 1939. A monographic survey of South African non-marine Mollusca.—*Ann. S. Afr. Mus.* **33**: 1–660.

Hendey, Q. B. 1976. The Pliocene fossil occurrences in 'E' Quarry, Langebaanweg, South Africa.—*Ann. S. Afr. Mus.* **69**: 215–247.

Kensley, B. F. 1972. Pliocene marine invertebrates from Langebaanweg, Cape Province.—*Ann. S. Afr. Mus.* **60**: 173–190.

McKenzie, K. G. 1971. Species list of South African freshwater Ostracoda with an appendix listing museum collections and some further determinations.—*Ann. S. Afr. Mus.* **57**: 157–213.

Nicklés, M. 1955. Scaphopodes et lamellibranches récoltés dans l'Ouest africain.—*Atlantide Rep.* **3**: 93–238.

STEPHENS, E. L. 1929. Fresh water aquatic vegetation of the south-western districts. *In:* ADAMSON, R. S., *et al., eds. The Botanical features of the south-western Cape Province.* Cape Town: Speciality Press.

TANKARD, A. J. 1975*a*. Thermally anomalous Late Pleistocene molluscs from the south western Cape Province, South Africa.—*Ann. S. Afr. Mus.* **69**: 17–45.

TANKARD, A. J. 1975*b*. Varswater Formation of the Langebaanweg–Saldanha area, Cape Province.—*Trans. geol. Soc. S. Afr.* **77**: 265–283.

VAN BRUGGEN, A. C. 1970. Non Marine Mollusca. *In:* HANSTRÖM, B., BRINCK, P., & RUDEBECK, G., *eds. South African animal life* **14**: 444–476. Lund: Berlingska Boktryckeriet.